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ABSTRACT

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STRUCTURALLY INTEGRATED VERSUS STRUCTURALLY SEGREGATED MEMORY REPRESENTATIONS: IMPLICATIONS FOR THE DESIGN OF INSTRUCTIONAL MATERIALS

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Abstract

Two kinds of memory organization are distinguished: segregated versus integrated. In segregated memory organizations, related learned propositions have separate memory representations. In integrated memory organizations, memory representations of related propositions share common sub-representations. Segregated memory organizations facilitate memory for individual propositions, while integrated memory organizations facilitate higher-order processing, such as inferencing. It is suggested that the nature of acquired memory organizations and, consequently, performance on memory and inferencing tasks can be influenced by simple wording manipulations on study materials. Experimental results support these assumptions.

Students regularly receive conceptually related information from several different sources. For example, a student might study several textbook chapters concerning U.S. involvement in World War II. All of the studied information would be related at a general topical level. In addition, some of the information would be related in more specific ways. For example, the student might learn that the U.S. took various actions during the war, including that the U.S. bombed Hiroshima and Nagasaki, liberated France, gave monetary aid to China, etc.

The student's task is not simply to memorize studied information, but to organize it in memory. A critical feature of this memory organization is the degree to which particular subsets of the information are structurally integrated or segregated. Structurally integrated memory representations share common sub-representations, while structurally segregated memory representations do not. Consider the memory organization of knowledge about U.S. involvement in World War II shown in Figure 1. In this organization, all propositions regarding actions taken by the U.S. are structurally integrated because they all share a common sub-representation of "U.S." Alternatively, consider the memory organization shown in Figure 2. In this organization, propositions regarding actions against enemies ("bombs," "captures") are structurally integrated and propositions regarding actions toward allies ("commands," "aids," "liberates") are structurally integrated, but the two sets of propositions are structurally segregated. In other words, separate sub-

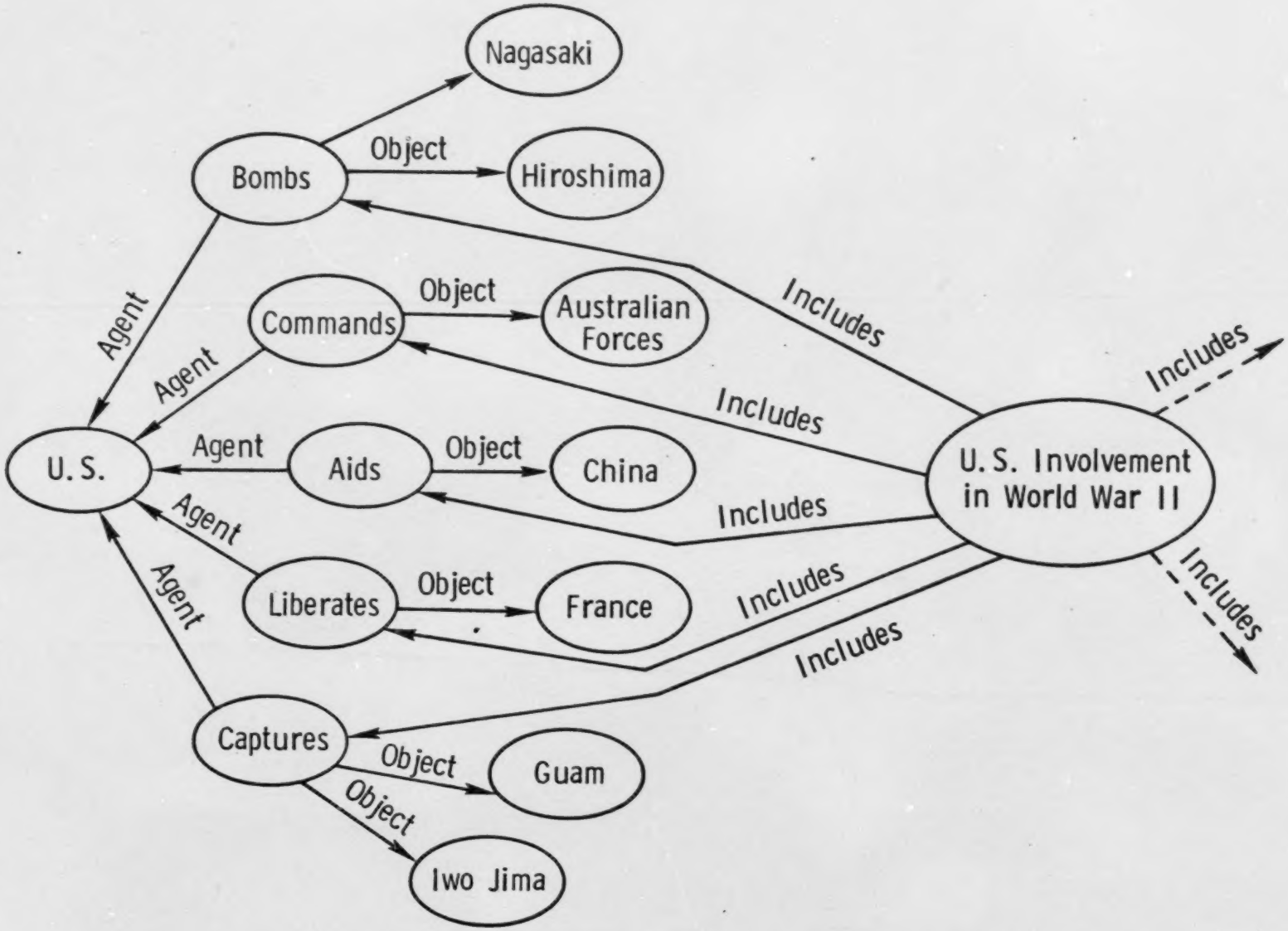

Figure 1. Integrated memory organization for propositions regarding U.S. actions during World War II.

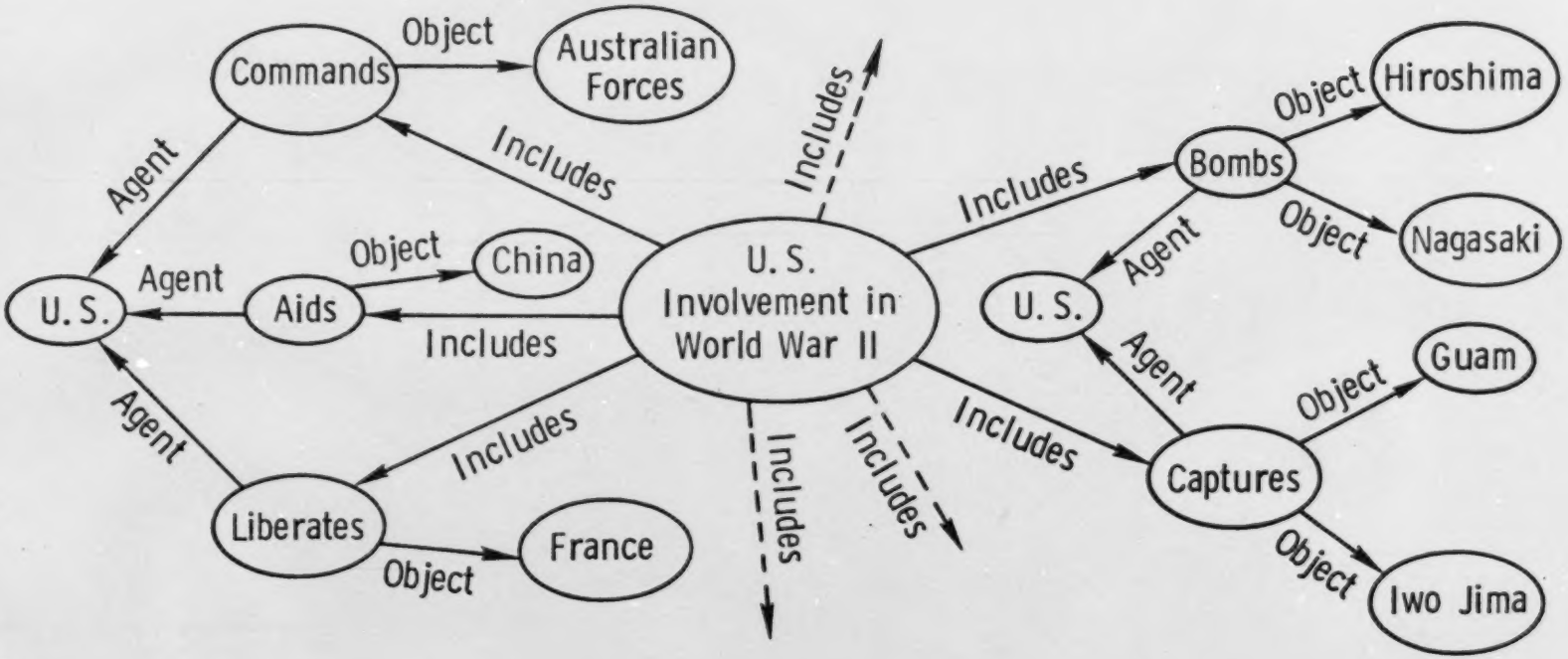

Figure 2. Segregated memory organizations for propositions regarding U.S. actions toward allies versus enemies during World War II.

representations of "U.S." are involved in representations of the two sets of propositions.

Structurally integrated and structurally segregated memory representations have different properties. Structurally integrated representations emphasize the common features of related propositions and the configural effects produced by simultaneous consideration of all related propositions. They deemphasize individual propositions and, as a result, may exhibit interference during attempts to access isolated propositions. These effects derive from a tendency for any activation of the shared sub-representation to diffuse throughout all of the propositions, rather than being focused on any one proposition. Structurally segregated representations, on the other hand, obscure the common features of related propositions and any configural effects, while emphasizing individual propositions. These effects derive from a tendency for activation to be concentrated on particular propositions, with fewer structural linkages present to diffuse that activation among conceptually related memory representations.

Each kind of memory representation is adaptive under certain circumstances, depending upon the kinds of relations that occur in the studied text(s) and the nature of the performance required following study. Integrated memory representations are adaptive for higher-order cognitive processing, such as summarizing, generalizing, and inferencing. Segregated memory representations

are adaptive for fast, accurate learning and remembering of specific propositions. For example, after learning about various actions taken by the U.S. during World War II, the student might be required to draw inferences about the the general nature of U.S. activities toward allies. A structurally integrated memory representation of the relevant propositions, as illustrated in Figure 2, would facilitate inferencing in two ways. First, it would emphasize the common characteristics of the various actions toward allies (e.g. that the U.S. actively cooperated with allies). Second, it would facilitate simultaneous activation of all relevant propositions, enabling more elaborate cognitive analysis of the configural properties of actions toward allies (e.g. that the U.S. played a supportive leadership role toward allies). It might also be important for the student to remember specific actions toward allies. Structurally segregating memory representations of these propositions from those regarding actions toward enemies would facilitate performance in two ways. First, it would maximize the probability that individual propositions would be retrieved, because processing capacity would be divided among a relatively small number of proposition representations. Second, it would restrict activation of related propositions that might be confused with target propositions.

Organizing studied information in memory in an appropriate way is a critical aspect of the learning process. It is difficult because the student must first detect conceptual relations in the studied material and then determine which

propositions should be organized in structurally integrated versus structurally segregated memory representations. Further, establishing integrated versus segregated memory representations may not always (or ever) result from conscious decisions, but may sometimes occur automatically during reading. Thus, it seems likely that even good students will frequently acquire sub-optimal memory representations.

An obvious implication of the above analysis is that learning could be improved by assisting the student in detecting conceptual relations in studied material, determining which propositions should be organized in structurally integrated and segregated memory representations, and establishing the appropriate memory organization. If these processes occur automatically during reading, it may not be sufficient to provide some adjunct aid to the student during study. A better approach is to present the studied material in a form that automatically promotes the desired memory organization.

One technique for doing this is suggested by a recently proposed theory of the representation of meaning in memory (Hayes-Roth & Hayes-Roth, 1977). The theory assumes that the meaning of a verbal input is represented in memory in a linguistic form that bears a close resemblance to the surface form of the input. In particular, the words used in the input are assumed to be the basic units of its memory representation. The theory contrasts with the more prevalent view that the

meaning of a verbal input is represented in memory in a canonical form that is more abstract than the words used in the input.

One of the findings of Hayes-Roth and Hayes-Roth (1977) is particularly relevant here. Several previous studies had shown that when students learn propositions that involve common words (e.g. all of the propositions regarding U.S. activity during World War II), interference in memory occurs for each of them (Anderson, 1974; Hayes-Roth, 1977; Thorndyke & Bower, 1974). That is, students do not remember the propositions as well as they remember those that are unrelated to other learned propositions. This suggests that the students formed integrated memory representations of related learned propositions. Hayes-Roth and Hayes-Roth found that this kind of interference could be eliminated by paraphrasing the common words in one of the sentences (e.g. by replacing "U.S." with "American" in propositions regarding U.S. activity toward enemies). This finding suggests that paraphrasing the common words induced segregated memory representations of related propositions. The implications are obvious: If memory for individual propositions is desired, conceptual relations in studied material should be worded as differently as possible to promote development of segregated memory representations. If higher-order processing, such as inferencing, is desired, conceptual relations should be worded as similarly as possible to promote development of integrated representations. We have been investigating these prescriptions in learning contexts closely approximating natural

instructional contexts. Two examples are discussed below.

Consider the case in which the student must read several texts that are similar in the general outline of the information presented, but different in detail. The following excerpts are from two texts of this sort:

> Text 1. The Spring Episode was the first revolution in Morinthia. The outbreak occurred shortly before dawn on April 17, 1843. The revolution was undoubtedly caused by the tyranny imposed upon the Morinthian people by King Egbert, the dictator. For months, Egbert had extracted half of all the earnings of the people. However, the immediate cause of the outbreak appeared to be a minor crime committed several days earlier. A peasant had poached several chickens from the royal henhouse to serve at his daughter's wedding. It seemed a minor offense to the people, but in Morinthia, everyone who disobeyed the law was punished severely...
>
> Text 2. The November Episode was the first revolution in Caledia. The outbreak occurred shortly after midnight on November 1, 1737. The revolution was undoubtedly caused by the tyranny imposed upon the Caledian people by King Ferdinand, the dictator. For months, Ferdinand had refused to allow the representatives of the people to participate in the government. However, the immediate cause of the outbreak appeared to be a minor crime committed several days earlier. A stable boy had drunk a bit too freely at the local tavern and disturbed the town with his singing while making his way home. It seemed a minor offense to the people, but in Caledia, everyone who disobeyed the law was punished severely...

Texts 1 and 2 describe similar political events in two different countries. In both cases, a first revolution is named, dated, and attributed to the tyranny of a dictatorial king. The immediate cause of each revolution is a minor crime committed by an ordinary person who is punished severely. In both cases, it is commonplace to punish severely those who disobey the law. The

two texts also differ in important ways: the name and time of occurrence of the revolution, the name of the king, the expression of the king's tyranny, and the particular crime committed.

Because the conceptual relations in texts 1 and 2 are worded identically, structural integration of the memory representations of the two texts will be automatic. In other words, the memory representations of the texts will share many common sub-representations. This integration will result in interference in the student's ability to remember which details are associated with which revolution. In order to deter integration of the two memory representations, minimize the interference, and thereby improve the student's retention of the material, the conceptual relations should be paraphrased in one of the texts, as in the following alternative to text 2:

> Text 3. The first Caledian rebellion was called the November Episode. The uprising happened on November 1, 1737, just after midnight. The oppression of the Caledians by King Ferdinand, the autocrat, was clearly the cause of the rebellion. For months, Ferdinand had refused to allow the representatives of the people to participate in the government. But an insignificant crime which had occurred a few days before seemed to be the immediate cause of the uprising. A stable boy had drunk too much at the local tavern and disturbed the town while making his way home. The Caledian citizens thought it was an insignificant misdemeanor, but all those who violated the Caledian law were punished harshly...

We have been working with pairs of related texts in which conceptual relations are represented by either same (e.g., text 2) or paraphrase (e.g., text 3) wordings. We find, over a

variety of topics, that students remember text-specific details better (20% improvement) when the conceptual relation are paraphrased. Thus, a simple technique for improving the effectiveness of instructional materials is to word texts that are similar in outline, but different in detail, as differently as possible to promote segregated memory representations.

On the other hand, some learning tasks can be facilitated by establishing integrated memory representations. One such task is inferencing from several texts that present complementary information. Consider, for example, the following excerpt:

> Text 4. The second Morinthian rebellion was called the Curfew Episode. It provided the setting for several important events in the life of Albert Profiro, a young Morinthian tradesman. The uprising happened on March 22, 1844, the day after a group of youths were discovered to have violated the curfew law. The law had been a source of friction between the townspeople and the government for some time. The people welcomed the opportunity to flood the streets, throwing stones and damaging property. Albert took it upon himself to try to calm the people. Although Albert hated all autocrats and their governments, he hated anarchy in the streets even more...

Text 4 describes political events that are complementary to those described in text 1. Both texts are about Morinthian revolutions and some of the associated events. Text 1 describes the first revolution: its causes, what happened during the revolution, and how it was resolved. Text 4 focuses on how the second revolution affected the life of a particular individual. Note that integration of the information in both texts would enable one to draw certain inferences that could not be drawn given knowledge

of the information in only one or the other of the texts. For example, one could infer that Albert Profiro hated King Egbert because (1) King Egbert was a dictator (Text 1), (2) Albert Profiro hated all autocrats (Text 4), and (3) a dictator is an autocrat (by definition).

The student's ability to draw appropriate inferences depends upon integrating the relevant premises from the two texts, that is, upon recognizing conceptual relations between the representations of the two texts (e.g., between "dictator" and "autocrat"). Because conceptual relations in the two texts are worded differently, distinctive memory representations will be established automatically, hampering integration of the relevant premises. In order to promote establishment of common sub-representations, facilitate integration of the relevant premises, and thereby improve the student's ability to draw appropriate inferences, the conceptual relations between the two texts should be worded as similarly as possible, as in the following alternative to text 4:

> Text 5. The Curfew Episode was the second revolution in Morinthia. It provided the setting for several important events in the life of Albert Profiro, a young Morinthian tradesman. The outbreak occurred on March 22, 1844, the day after a group of youths were discovered to have disobeyed the curfew law. The law had been a source of friction between the townspeople and the government for some time. The people welcomed the opportunity to flood the streets, throwing stones and damaging property. Albert took it upon himself to try to calm the people. Although Albert hated all dictators and their governments, he hated anarchy in the streets even more...

We have been working with pairs of related texts in which conceptual relations are represented by either same (e.g., text 4) or paraphrase (e.g., text 5) wordings. We find, over a variety of topics, that students draw more accurate inferences (50% improvement) when the conceptual relations have the same wordings. This is true even when students are permitted to look back at the text during inferencing. Thus, a simple technique for improving the effectiveness of instructional materials is to word texts that present complementary information as similarly as possible to promote integrated memory representations.

Conclusion

Simple wording manipulations on study materials can be used to influence the organization of the material in memory and students' ability to use the stored information. Differently worded texts promote structurally segregrated memory representations, facilitating memory for specific propositions. Similarly worded texts promote structurally integrated memory representations, facilitating inferencing and other higher-order cognitive processing of the stored information.

References

Anderson, J. R. Retrieval of propositional information from long-term memory. Cognitive Psychology, 1974, 6, 451-474.

Hayes-Roth, B. Evolution of cognitive structures and processes. Psychological Review, 1977, in press.

Hayes-Roth, B. and Hayes-Roth, F. The prominence of lexical information in memory representations of meaning. Journal of Verbal Learning and Verbal Behavior, 1977, in press.

Thorndyke, P. W., & Bower, G. H. Storage and retrieval processes in sentence memory. Cognitive Psychology, 1974, 6, 515-543.